Global decision method for video frequency coding

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Abstract

The present invention belongs to the field of motion image coding technology. Said invention includes four portions of motion estimation, frame prediction and prediction error generation, transformation and quantification, image reconstruction and entropy coding. It is characterized by that in the motion estimation portion, the overall decision device for determining result per stage in the course of matching hierarchical search block is set up to judge that whether the current frame image reconstruction error exceeds the reconstruction error of the last frame image or not. The described overall decision device adopts reconstruction error decision standard, and its adoption can greatly raise coding speed.

Claim

1. the overall judgement method of a video coding including motion estimation, frame prediction and prediction error formation, varies and quantizes image reconstruction, entropy coding four bibliographic categories branch; Characterized in: in the motion estimation part, set up every grade of overall situation judgement ware that the result goes on adjudicating in the hierarchical search piece matching process, judge whether current frame image reconstruction error surpasses the reconstruction error of last frame image; Whether this judgement ware can be controlled each part of code process, control (ⅰ) search promptly and stop; DCT is sent into by (ⅱ) frame difference signal whether to be varied and handles; The overall situation judgement ware that the invention was said adopts rebuilds error judgement criterion.

2. the overall judgement method of video coding according to claim 1 characterized in, the reconstruction error judgement criterion of saying is: to current frame (k frame) macro block 1, if satisfy SAD in the motion estimation $_1{}^{(k)}(i, j) E_{econ1}{}^{(k)}$, $(i, j) \in S$, then current motion estimation can finish, and (i, j) promptly for the macro block 1's that will look for motion vector, other code operations of macro block 1 in addition, prediction error calculation and DCT, Q, IQ, IDCT can save.

The overall judgement method of video coding

The invention belongs to the motion diagram like the coding techniques field.

In the current information age, the storage and the transmission of image become more and more important.Because visual initial data information quantity is very huge, the storage medium of limited capacity save with the compression like, pictorial data of the information channel transmission diagram of limited capacity, be essential to the motion diagram like encoding also.The motion diagram

is through using multipurposely the image signal in the redundancy of time, space, statistics tripartite like the code, and the knowledge of scene, human vision characteristic realize.Comparatively ripe coding method at present is the hybrid coding method of having synthesized predictive coding, transition coding, several kinds of coding methods of entropy coding and motion compensation technique, and the block-diagram is as illustrated in FIG. 1.The following step of implementation method is realized to its code: motion estimation ME is made to the current image of input and last one reconstruction image in (1),The motion estimation obtains motion vector MV; (2), rebuild the frame according to the motion vector to last one and make prediction P,The acquisition to the prognostic chart of current image like; (3), deduct current visual prognostic chart like obtaining prediction error PE with current image; (4), make discrete cosine transform DCT and quantize Q the prediction error; (5), it obtains current coding image to make variable length encoding VLC to the result of (4); Make re-quantization IQ, contrary discrete cosine transform IDCT with (6) to the result of (4) and obtain the prediction error rebuild,Rebuild the image with current prognostic chart before obtaining like the summation again,It rebuilds the image to become last one through frame memory FM.

In Fig. 1 each step the function as follows: the calculation (subtracter) of motion estimation, prediction and prediction error constitutes the predictive coding, is in order to eliminate the dependence of image signal on the time.Certain a part of certain partly process motion by last frame image that visual dependence on the time showed as current frame image obtains.And the motion comes the description through the motion vector, and the motion vector will be tried to achieve exactly to the motion estimation, and the prediction is then compensate, offset between current frame image and a last frame image part change because of the signal of motion production according to the motion vector.Discrete cosine transform DCT constitutes the transition coding, and the purpose is in order to eliminate the dependence of image signal on the space.It is the needs of entropy coding at the back to quantize Q, is again to have utilized the human vision characteristic to improve the quality of

code.Variable length encoding VLC constitutes the entropy coding, has further eliminated the dependence of the statistics of image signal.Re-quantization IQ, contrary discrete cosine transform IDCT, adder realization image reconstruction provide the object of reference for the prediction.

The encoder of the above-mentioned hybrid coding method of present realization is as illustrated in FIG. 2. In the picture piece DCT, piece Q, piece IQ, piece IDCT, a piece VLC be in a frame () the image one (be 88 pixels according to the international standard) for the unit advance discrete cosine transform DCT, quantification Q, re-quantization IQ, against discrete cosine transform IDCT, variable length encoding VLC. Macro block P is the unit with a macro block (being 6 pieces according to the international standard) in the frame image to predict P. Macro block MV indicates the motion vector of macro block. 0 is that 88 elements all are 0 in the piece.

The working process that this encoder was realized is: at first, a frame () image is the unit with one (88 pixel) or a macro block (6 pieces) and encodes. Secondly, whole code process is divided into two parts: the motion estimation is shown like the virtual frame of Fig. 2 with the code core. Current frame macro block at first gets into the motion estimation part and makes the motion estimation, and the motion estimation obtains motion vector MV, imports the code core and encodes to current frame macro block, specifically is divided into following step:

At first, make the motion estimation to current frame macro block and last one reconstruction frame macro block.The motion estimation is divided into whole pixel search and two steps are searched for to half pixel.The searching method that moves is in grades adopted in the search of whole pixel, and it is hierarchical to be about to search for the territory: dead point, little search territory, search for the territory greatly.This is typical 3 grades, and concrete realization can change, if 2 grades: dead point, little search territory, is about to little search territory and searches for the territory greatly merge; Or 4 grades: dead point, little

search territory, search for territory, bigger search territory greatly, soon search for territory further division two-stage greatly.Will judge after the two-stage search territory search in the front judge whether satisfy the criterion and can stop whole pixel search and enter into search of half pixel and Hou Mian code core, specific judgement criterion probably is diversified.

Secondly, advance to the code core after, the motion vector that obtains the macro block according to the motion estimation is rebuild the frame macro block to last one and is predicted and obtain current prediction frame macro block, then deducts current prediction frame macro block with the subtracter with current frame macro block and calculate the prediction error, does DCT, Q, entropy coding (VLC) and image reconstruction after that.

The not enough of implementation method of this kind of encoder lies in that code speed is high inadequately. To QCIF form simple motion image sequence (like the Claire sequence), utilize Pentium-133 PC still can't accomplish software real-time coding (25 frame / second).

The objective of the invention is to overcome the weak point of prior art, set up the image on the basis of original coding method in the judgements of a large amount of unneccessary operations, improve encoder speed.

The overall judgement method of an invention proposition video coding,Including motion estimation, frame prediction and prediction error formation,Transform and quantification,Image reconstruction, entropy coding four bibliographic categories branch; Characterized in: in the motion estimation part,Set up every grade of overall situation judgement ware that the result goes on adjudicating in the hierarchical search piece matching process,Whether the reconstruction error of judging current frame image surpasses the visual reconstruction error of a last frame; This judgement ware can be controlled each part of code process,Whether control (ⅰ) search promptly stops; DCT is sent into by (ⅱ) frame difference signal whether to be varied and handles; The overall situation judgement ware that the invention was said adopts rebuilds error judgement

criterion.

The reconstruction error judgement criterion that the invention was said is: to current frame (k frame) macro block l, if satisfy in the motion estimation

$SAD_1^{(k)}(i, j) E_{reconl}^{(k)}$, $(i, j) \in S$, then current motion estimation can finish, and (i, j) promptly for the macro block l's that will look for motion vector, other code operations of macro block l in addition, prediction error calculation and DCT, Q, IQ, IDCT can save; If the motion estimation is then proceeded to inequality above unsatisfied.

The principle of the reconstruction error judgement criterion that the invention was adopted is sketched as follows: at the motion estimation, adopt the piece matching method usually, calculate SAD (Sum of AbsoluteDifference) the value of macro block, SAD wherein $_1^{(k)}$For k frame macro block l's SAD value, (i, j) is candidate's motion vector, and S is search territory, $I_o^{(k)}$For the original frame gray value of k, $I_o^{(k-1)}$For the original frame gray value of k-1, the size of macro block is N. Previous frame (k-1 frame) macro block l's reconstruction error $E_{reconl}^{(k-1)}$Can obtain by following formula calculation,

I wherein $_r^{(k-1)}$For k-1 frame reconstruction frame. It is then to rebuild error judgement criterion: to current frame (k frame) macro block l, if satisfy in the motion estimation

$SAD_1^{(k)}(i, j) E_{reconl}^{(k)}$, $(i, j) \in S$, (3) then current motion estimation can finish, and (i, j) promptly for the macro block l's that will look for motion vector, other code operations of macro block l in addition, prediction error calculation and DCT, Q, IQ, IDCT can save; If the motion estimation is then proceeded in unsatisfied inequality (3).

The realization block diagram of the said novel video coding ware of the invention is as illustrated in FIG. 3, and its working process is: at first, to current frame macro block with last one rebuild the frame macro block and make the motion estimation.The motion estimation is including whole pixel search and the search of

half pixel.The searching method that moves is in grades adopted in the search of whole pixel, and it is hierarchical to search for the territory: dead point, little search territory, search for the territory greatly.(this is typical 3 grades, and concrete realization can change, and is the same).After each level search territory search, all gets into overall situation judgement ware G, judge current this one-level search down current input macro block whether satisfy and rebuild error criterion, if satisfy the then not only search procedure end of current macro block, the whole code process of this macro block has also finished in addition, encodes to forward next macro block to; If the unsatisfied search that then continues the next stage.Obtain the motion vector after the search of half pixel, get into the code core.

Secondly, advance to the code core after, the motion vector that obtains the macro block according to the motion estimation is rebuild the frame macro block to last one and is predicted and obtain current prediction frame macro block, then deducts current prediction frame macro block calculation prediction error with current frame macro block, does DCT, Q, entropy coding (VLC) and image reconstruction after that.

Combining Fig. 3 and Fig. 2, can finding out that the invention compared with conventional techniques has following characteristics: first, whole pixel part in the motion estimation of the invention sets up overall situation judgement ware G after each grade search of whole pixel search, in case the criterion satisfies among the judgement ware G, then the whole code process to this macro block has just finished, also is exactly not only to finish whole pixel search procedure, and half pixel search in addition, whole code core all needn't have been done, thereby have improved the speed of encoding greatly.The second, to judgement ware G, we have adopted the efficient to rebuild error criterion.Whether this criterion not only can be controlled the search and stop, but also can the control frame difference signal whether sends into DCT and vary and handle.

Brief description Fig. 1 of figure is existing hybrid coding

method block diagram Fig. 2 is the invention for existing video coding ware structure block diagram Fig. 3 video coding ware structure block diagram

Adopt invention coding method to realize that an embodiment structure of video coding ware is as illustrated in FIG. 3.Its working process is ditto said.This embodiment is provided on the Pentium-200 PC the code parameter of the simple sequence Claire sequence of QCIF form and complicated sequence Foreman sequence and code speed: Claire sequence as follows: I frame quantization parameter is 10, P frame quantization parameter and is 10.The two-stage search is adopted in whole pixel search in the motion estimation: dead point, little search territory, and the zone length is 5, and each grade searching algorithm is three footworks of sampling method, and the piece matching operation adopts inferior sampling method.The result: code frame per second (speed) reached for average 70 frame / seconds.Foreman sequence: I frame quantization parameter is 20, P frame quantization parameter and is 20.Tertiary search is adopted in whole pixel search in the motion estimation: dead point, little motion regional (the zone length is 4), searches for each grade searching algorithm of territory (the zone length is 10) greatly and is three footworks, and the piece matching operation adopts inferior sampling method.The result: code frame per second (speed) reached for average 30 frame / seconds.

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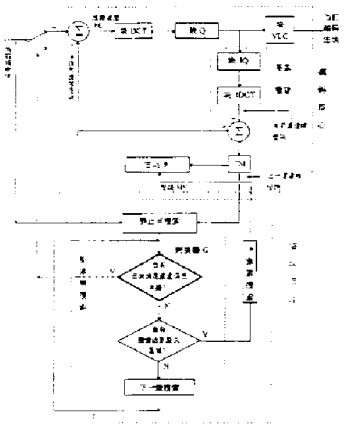
[54]发明名称 视频编码的全局判决方法

[57]摘要

本发明属运动图象编码技术领域。本发明包括运动估计、帧预测与预测误差生 成,变换与量化,图象重建、熵编码四部分;其特征在于:在运动估计部分,设置对分级搜索块匹配过程中每级结果进行判决的全局判决器,判断当前帧图 象重建误差是否超过上一帧图象的重建误差;所说的全局判决器采用重建误差 判决准则。采用本发明可大大提高了编码的速度。



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权 利 要 求 书

1．一种视频编码的全局判决方法，包括运动估计、帧预测与预测误差生成，变换与量化，图象重建、熵编码四部分；其特征在于：在运动估计部分，设置对分级搜索块匹配过程中每级结果进行判决的全局判决器，判断当前帧图象重建误差是否超过上一帧图象的重建误差；这一判决器能对编码过程的各部分进行控制，即控制 (i) 搜索是否停止；(ii) 帧差信号是否送入 DCT 进行变换与处理；本发明所说的全局判决器采用重建误差判决准则。

2．如权利要求 1 所述的视频编码的全局判决方法，其特征在于，所说的重建误差判决准则为：对当前帧(第 k 帧)宏块 l，若在运动估计中满足 $SAD_l^{(k)}(i, j) \leq E_{recon\,l}^{(k)}$，$(i, j) \in S$，

则当前运动估计可以结束，(i, j)即为要找的宏块 l 的运动向量，而且宏块 l 的其它编码运算，预测误差计算及 DCT、Q、IQ、IDCT 都可省去。

说　明　书

视频编码的全局判决方法

本发明属运动图象编码技术领域。

在当今信息化时代，图象的存储和传输变得愈来愈重要。由于图象原始数据信息量十分巨大，要在有限容量的存储介质进行存储和有限容量的信息通道传输图象，图象数据的压缩，也就是对运动图象进行编码是必不可少的。运动图象编码是通过综合利用图象信号在时间、空间、统计三方面的冗余度，以及场景的知识、人的视觉特性来实现的。目前较为成熟的编码方法是综合了预测编码、变换编码、熵编码几种编码方法以及运动补偿技术的混合编码方法，方框图如图 1 所示。 其编码实现实现方法如下步骤：

(1)对输入的当前图象和上一重建图象作运动估计 ME，运动估计得到运动向量 MV；

(2)根据运动向量对上一重建帧作预测 P，获得对当前图象的预测图象；

(3)将当前图象减去当前图象的预测图象得到预测误差 PE；

(4)对预测误差作离散余弦变换 DCT 和量化 Q；

(5)对(4)的结果作变长编码 VLC 得到当前编码图象；和

(6) 对(4)的结果作逆量化 IQ、逆离散余弦变换 IDCT 得到重建的预测误差，再与当前预测图象相加得到当前重建图象，经帧存储器 FM 变成上一重建图象。

图 1 中各步骤的功能如下：

• 运动估计、预测及预测误差的计算(减法器)构成预测编码，是为了消除图象信号在时间上的相关性。图象在时间上的相关性表现为当前帧图象的某一部分是由上一帧图象的某一部分经过运动而得到的。而运动是通过运动向量来描述的，运动估计就是要求得运动向量，而预测则是根据运动向量来补偿、抵消当前帧图象与上一帧图象部分之间因运动而产生的信号的变化。

• 离散余弦变换 DCT 构成变换编码，目的是为了消除图象信号在空间上的相关性。量化 Q 既是后面熵编码的需要，又是利用了人的视觉特性来提高编码的质量。

• 变长编码 VLC 构成熵编码，进一步消除了图象信号的统计的相关性。

• 逆量化 IQ、逆离散余弦变换 IDCT、加法器实现图象重建，为预测提供参照物。

现有实现上述混合编码方法的编码器如图 2 所示。图中块 DCT、块 Q、块 IQ、块 IDCT、块 VLC 是指一帧(一幅)图象中一块(按国际标准为 8×8 象素)为单位进离散余弦变换 DCT、量化 Q、逆量化 IQ、逆离散余弦变换 IDCT、变长编码 VLC。宏块 P 是指以一帧图象中一个宏块(按国际

标准为 6 个块)为单位进行预测 P。宏块 MV 指宏块的运动向量。0 块是指块中 8×8 个元素都为 0。

该编码器实现的工作过程为：

首先，一帧(一幅)图象是以一块(8×8 象素)或一宏块(6 个块)为单位进行编码的。其次，整个编码过程分为两部分：运动估计和编码核心如图 2 虚框所示。当前帧宏块首先进入运动估计部分作运动估计，运动估计得到运动向量 MV，输入到编码核心对当前帧宏块进行编码，具体分为如下步骤：

首先，对当前帧宏块和上一重建帧宏块作运动估计。运动估计分为整象素搜索和半象素搜索两步。整象素搜索采用分级运动搜索方法，即将搜索域分级：静止点、小搜索域、大搜索域。这是典型的 3 级，具体实现可以有变化，如 2 级：静止点、小搜索域，即将小搜索域与大搜索域合并；或 4 级：静止点、小搜索域、大搜索域、更大搜索域，即将大搜索域再细分两级。在前两级搜索域搜索结束后要进行判断，判断是否满足判据而可以停止整象素搜索进入到半象素搜索和后面的编码核心，具体的判决准则可能是多种多样的。

其次，进到编码核心以后，根据运动估计得到宏块的运动向量 对上一重建帧宏块进行预测得到当前预测帧宏块，然后用减法器将当前帧宏块减去当前预测帧宏块计算预测误差，接着做 DCT、Q、熵编码(VLC)和图象重建。

这种编码器的实现方法的不足在于编码速度不够高。对 QCIF 格式简单运动图象序列(如 Claire 序列)，利用 Pentium-133 PC 仍无法做到软件实时编码(25 帧/秒)。

本发明的目的在于克服已有技术的不足之处，在原有编码方法的基础上增设对图象中大量不必要运算的判断，提高编码器速度。

本发明提出一种视频编码的全局判决方法，包括运动估计、帧预测与预测误差生成，变换与量化，图象重建、熵编码四部分；其特征在于：在运动估计部分，设置对分级搜索块匹配过程中每级结果进行判决的全局判决器，判断当前帧图象的重建误差是否超过上一帧图象的重建误差；这一判决器能对编码过程的各部分进行控制，即控制 (i) 搜索是否停止；(ii) 帧差信号是否送入 DCT 进行变换与处理；本发明所说的全局判决器采用重建误差判决准则。

本发明所说的重建误差判决准则为：对当前帧(第 k 帧)宏块 l，若在运动估计中满足

$$SAD_l^{(k)}(i, j) \le E_{recon\,l}^{(k)},\ (i, j) \in S,$$

则当前运动估计可以结束，(i, j)即为要找的宏块 l 的运动向量，而且宏块 l 的其它编码运算，预测误差计算及 DCT、Q、IQ、IDCT 都可省去；若不满足上面不等式，则继续进行运动估计。

本发明采用的重建误差判决准则的原理简述如下：

在运动估计，通常采用块匹配法，要计算宏块的 SAD(Sum of Absolute Difference)值，

$$SAD_l^{(k)}(i,j)=\sum_{m=1}^{N}\sum_{n=1}^{N}\left|I_o^{(k)}(m,n)-I_o^{(k-1)}(m+i,n+j)\right|,(i,j)\in S \qquad (1)$$

其中$SAD_l^{(k)}$为第 k 帧宏块 l 的 SAD 值，(i, j) 为候选的运动向量，S 为搜索域，$I_o^{(k)}$为第 k 原始帧灰度值，$I_o^{(k-1)}$为第 k-1 原始帧灰度值，宏块的大小为 N×N。

前一帧(第 k-1 帧)宏块 l 的重建误差$E_{recon\,l}^{(k-1)}$可由下式计算得到，

$$E_{recon\,l}^{(k-1)}=\sum_{m=1}^{N}\sum_{n=1}^{N}\left|I_o^{(k-1)}(m,n)-I_r^{(k-1)}(m,n)\right| \qquad (2)$$

其中$I_r^{(k-1)}$为第 k-1 帧重建帧。

则重建误差判决准则为：对当前帧(第 k 帧)宏块 l，若在运动估计中满足

$$SAD_l^{(k)}(i,j)\le E_{recon\,l}^{(k)},\ (i,j)\in S, \qquad (3)$$

则当前运动估计可以结束，(i, j)即为要找的宏块 l 的运动向量，而且宏块 l 的其它编码运算，预测误差计算及 DCT、Q、IQ、IDCT 都可省去；若不满足不等式(3)，则继续进行运动估计。

本发明所述的新型视频编码器的实现框图如图 3 所示，其工作过程为：

首先，对当前帧宏块和上一重建帧宏块作运动估计。运动估计包括整象素搜索和半象素搜索。整象素搜索采用分级运动搜索方法，将搜索域分级：静止点、小搜索域、大搜索域。(这是典型的 3 级，具体实现可以有变化，同前)。在每一级搜索域搜索结束后，都进入全局判决器 G，判断在当前这一级搜索下当前输入宏块是否满足重建误差判据，若满足则不但当前宏块的搜索过程结束，而且该宏块的整个编码过程也已结束，编码转到下一宏块；若不满足则继续下一级的搜索。半象素搜索结束后得到运动向量，进入编码核心。

其次，进到编码核心以后，根据运动估计得到宏块的运动向量对上一重建帧宏块进行预测得到当前预测帧宏块，然后用当前帧宏块减去当前预测帧宏块计算预测误差，接着做 DCT、Q、熵编码(VLC)和图象重建。

结合图 3 与图 2，可以看出本发明与现有技术相比有如下特点：

第一，在本发明的运动估计中整象素部分，在整象素搜索的每一级搜索结束后设置全局判决器 G，判决器 G 中判据是一旦满足，则对该宏块的整个编码过程就结束了，也就是不但结束整象素搜索过程，而且连半象素搜索、整个编码核心都不必做了，从而大大提高了编码的速度。

第二，对判决器 G，我们采用了高效的重建误差判据。该判据不但可以

控制搜索是否停止，而且还可以控制帧差信号是否送入 DCT 进行变换与处理。

附图的简要说明

图 1 为已有的混合编码方法框图

图 2 为已有的视频编码器结构框图

图 3 为本发明的视频编码器结构框图

采用本发明编码方法实现视频编码器的一种实施例结构如图 3 所示。其工作过程同前所述。本实施例给出在 Pentium - 200 PC 机上对 QCIF 格式的简单序列 Claire 序列和复杂序列 Foreman 序列的编码参数及编码速度如下：

Claire 序列：I 帧量化参数为 10，P 帧量化参数为 10。运动估计中的整象素搜索采用两级搜索：静止点、小搜索域，区域长度为 5，每一级搜索算法为采样法三步法，块匹配运算采用亚采样方法。

结果：编码帧率(速率)达到平均 70 帧/秒。

Foreman 序列：I 帧量化参数为 20，P 帧量化参数为 20。运动估计中的整象素搜索采用三级搜索：静止点、小运动区域(区域长度为 4)，大搜索域(区域长度为 10)每一级搜索算法为三步法，块匹配运算采用亚采样方法。

结果：编码帧率(速率)达到平均 30 帧/秒。

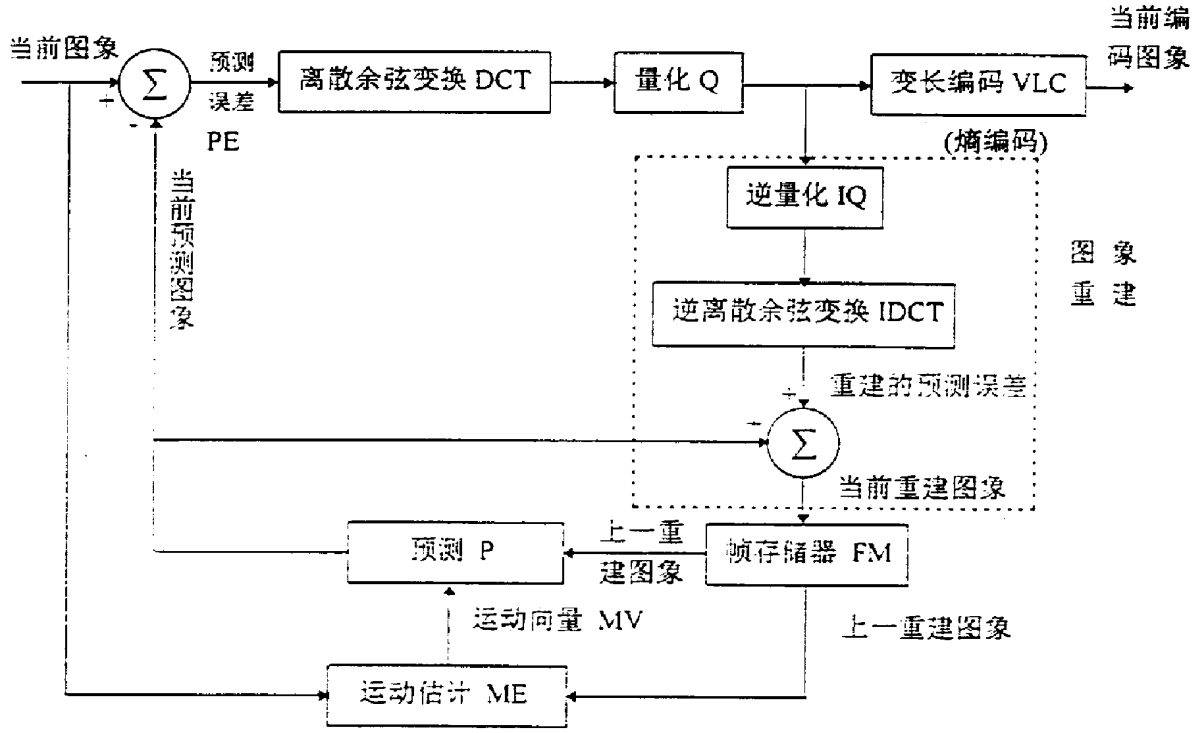
当前图象
预测
误差
PE
离散余弦变换 DCT
量化 Q
变长编码 VLC
当前编码图象
(熵编码)
当前预测图象
逆量化 IQ
逆离散余弦变换 IDCT
图象重建
重建的预测误差
当前重建图象
预测 P
上一重建图象
帧存储器 FM
运动向量 MV
上一重建图象
运动估计 ME

图 1

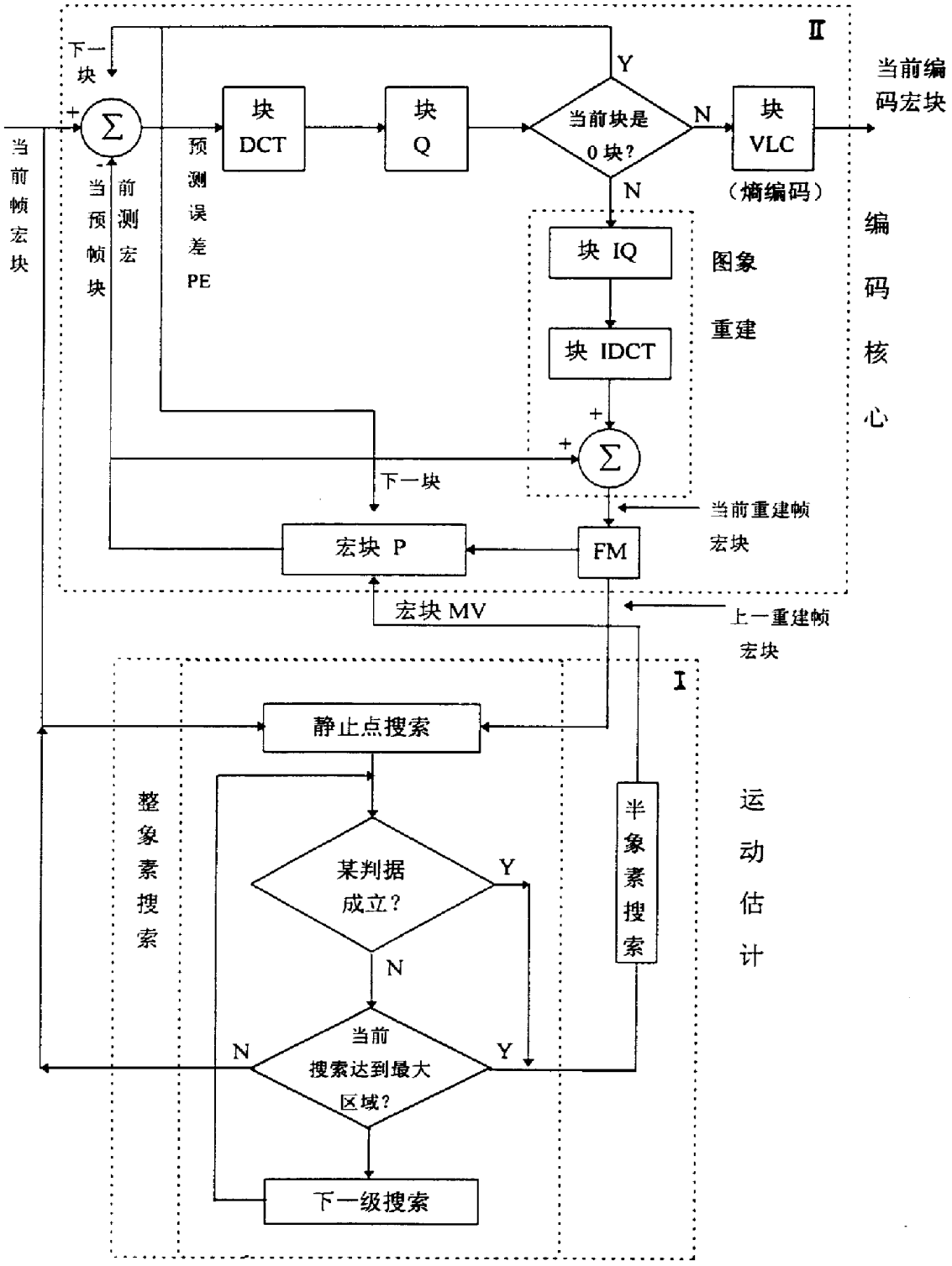
Ⅱ
下一块
当前帧宏块
当预帧块
前测宏
预测误差PE
块DCT
块Q
当前块是0块?
Y
N
块VLC
（熵编码）
当前编码宏块
编码核心
块 IQ
块 IDCT
图象重建
下一块
当前重建帧宏块
宏块 P
FM
宏块 MV
上一重建帧宏块
Ⅰ
静止点搜索
整象素搜索
某判据成立?
半象素搜索
当前搜索达到最大区域?
下一级搜索
运动估计

图 2

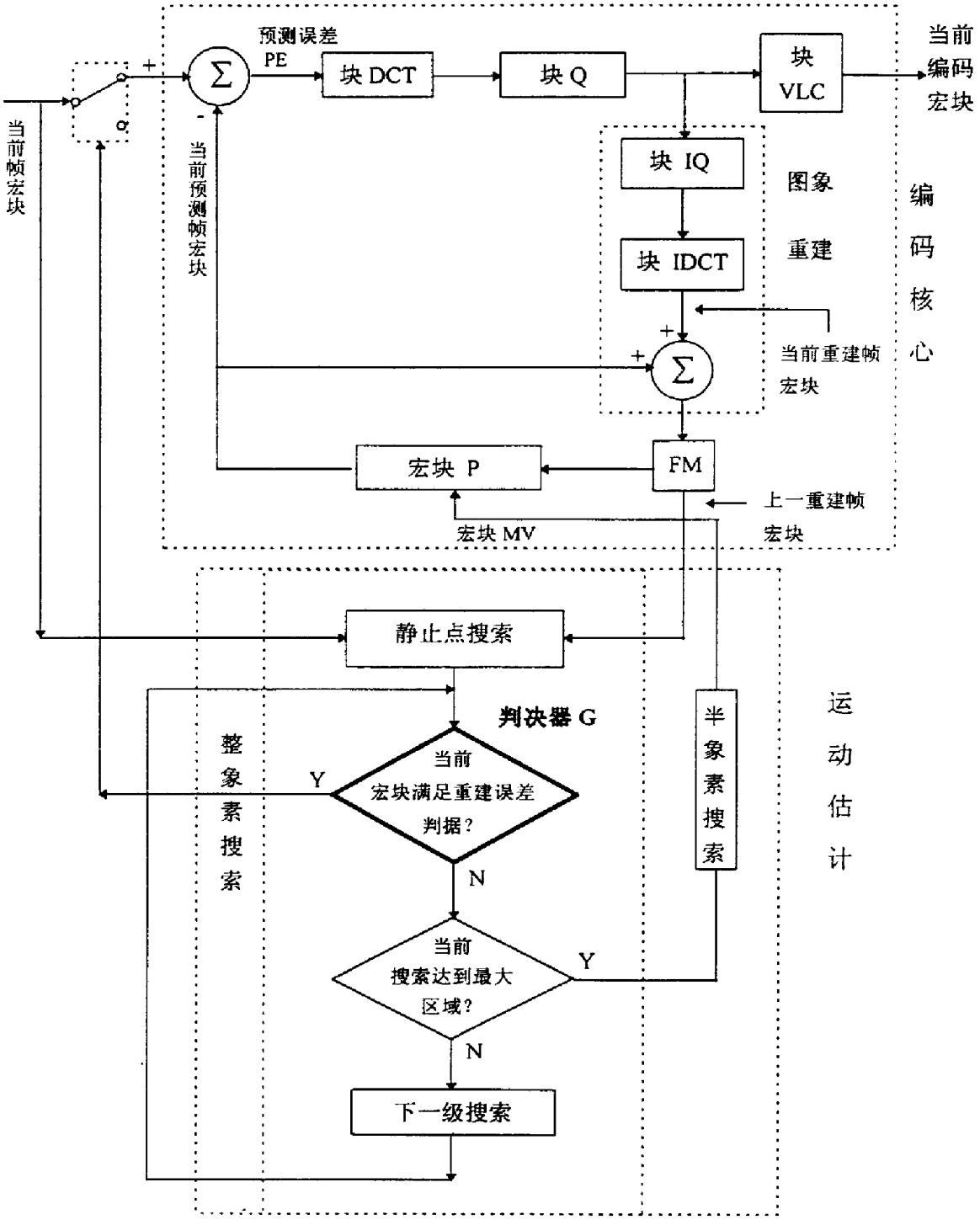
预测误差
PE
块 DCT
块 Q
块 VLC
当前编码宏块
当前帧宏块
当前预测帧宏块
块 IQ
图象
重建
块 IDCT
当前重建帧宏块
编码核心
宏块 P
FM
上一重建帧宏块
宏块 MV
静止点搜索
判决器 G
整象素搜索
当前宏块满足重建误差判据?
Y
N
半象素搜索
当前搜索达到最大区域?
Y
N
下一级搜索
运动估计

图 3